FINAL REPORT:

HOUSING EDUCATION PROGRAM IN POPAYAN, COLOMBIA

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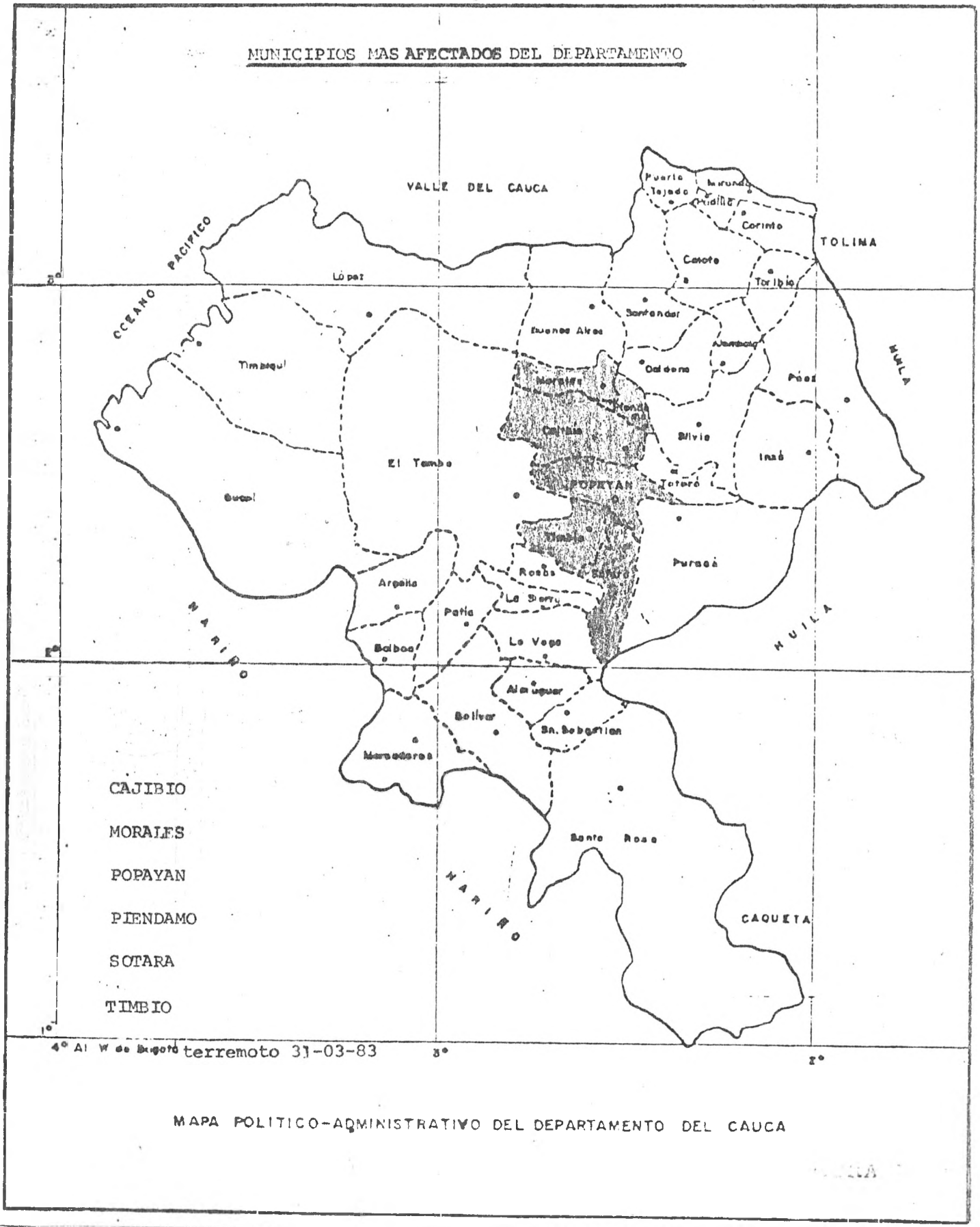
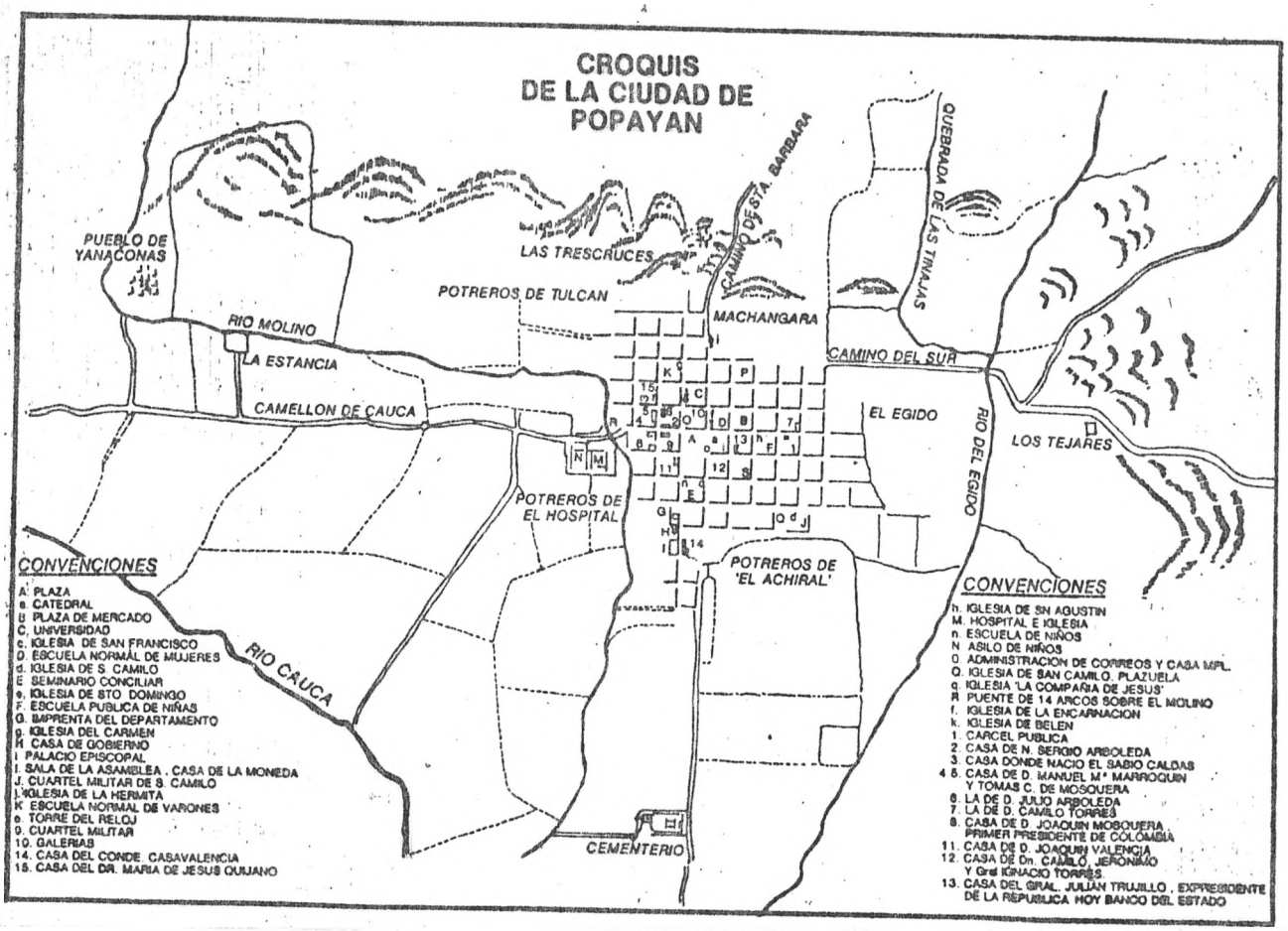
This is the final report for a project funded under AID Contract No. OTR-0000-C-00-3335-00. The objective was to design and conduct a program of housing education focused on introducing appropriate technology in housing repair and reinforcement following the earthquake in Popayán, Colombia. INTERTECT team members included Frederick C. Cuny, Eduardo A. Perez, Daniel Torrealva D., and A. James Viets. Augusto Espinosa S. of Areas, Ltda, worked with the team as soils engineer.

INTRODUCTION

At the request of Arquitecta Piedad Varona, Director of Planning for the City of Popayán, the AID Office of U.S. Foreign Disaster Assistance arranged for a team of housing specialists and earthquake engineers to visit Popayán. Members of the team coordinated their visit to coincide with the "Latin American Workshop on Seismic Resistant Earthen Construction" held in Lima, Peru, May 23-27, 1983. This team was led by Paul Thompson of INTERTECT and included a Peruvian earthquake engineer, a Colombian soils engineer, and a training aids specialist. The report of this team, "Popayán, Colombia, Post-Disaster Housing Survey: Feasibility Study for Training Program in Housing Repair" (Contract No. OTR-0000-0-00-3333-00) recommended that as a first priority, "... the Office of U.S. Foreign Disaster Assistance (AID/OFDA) should support a training program in the safe repair of earthen and masonry housing in low-income barrios of Popayán". As a second priority it was recommended that, "... the training program should be extended to include anti-seismic methods of construction, materials and design of new low-income housing oriented to self-help construction".



MAPA POLITICO-ADMINISTRATIVO DEL DEPARTAMENTO DEL CAUCA



EL TIEMPO - SABADO 28 DE MAYO DE 1983

After receiving an agreement in principle by the U.S. Embassy in Colombia and the Central Office of SENA (Servicio Nacional de Aprendizaje) in Bogotá, AID/OFDA requested that Paul Thompson return briefly to Colombia to work out a detailed agreement between AID, INTERTECT and SENA. The final contract between AID/OFDA and INTERTECT (Contract No. OTR-0000-C-00-3335-00) states the following objective: "To design and conduct a program of housing education focused on introducing appropriate technology in housing repair and reinforcement. The project will be carried out under the auspices of SENA and other institutions participating in the repair and rehabilitation work in Popayán and its immediate environs".

BRIEF DESCRIPTION OF THE AREA AND EARTHQUAKE HISTORY*

On March 31, 1983 at 8:13 in the morning an earthquake occurred in the vicinity of Popayán. Its magnitude was 5.5 on the Richter Scale, with an epicenter west of the urban area at a relatively shallow depth. The duration was 19 seconds, long enough to cause massive damage to the urban area and extensive damage to rural housing in the Municipio of Popayán and surrounding municipios. [An intensity of between 7 and 8 on the Modified Mercali Scale has been estimated.]

The city of Popayán is the capital of the Department of Cauca, sited on a high plain at 5,712 feet (1730m) above sea level. The city was founded in 1536 and soon became an aristocratic reserve of important families. Seventeen presidents of the Republic have come

*This section excerpted from the earlier project report, "Popayán, Colombia, Post-Disaster Housing Survey: Feasibility Study for Training Program in Housing Repair", INTERTECT, June 7, 1983, p. 2.

from Popayán. The historical and cultural importance of the city and its buildings are integral to the entire country.

The city also has a long history of earthquakes. Considerable damage resulted from earthquakes in 1827, 1834, and 1906, giving ample warning of future vulnerability. A primary factor in the earthquake risk of the area is the particularly poor soil condition found in much of the city.

OVERVIEW OF DAMAGE

There was widespread damage in virtually all sectors of the urban area, particularly with regard to the schools, hospitals, churches, public buildings and especially housing. Geographically, the greatest damage occurred in the 53-block area designated as an historic zone, virtually all of the low-income neighborhoods, and all construction in the low-lying areas between the rivers. Heavy damage was sustained by many engineered buildings throughout the city as well. Little or no damage was found only in upper-income housing on high ground and some engineered buildings scattered throughout the city.

Estimates of damage to the housing sector varied widely. No single report was available as representative of the "official" evaluation. The most credible from INTERTECT's point of view reported the following information:

	Number
Houses destroyed	2,470
Houses with major damage	6,885
Houses with minor damage	4,500

This represents 72% of the approximately 20,000 houses in Popayán. The value of the damage was estimated at approximately US$90,000,000.

In addition, it was estimated that in the historic area there were 1,200 living units located on the second floor above commercial establishments that were destroyed, representing a replacement cost of US$135,000,000. The extraordinarily high cost was based on the assumption that the earthen structures would be restored to their pre-disaster character and construction technology. The older, lower-income barrios (especially in the lower areas of the city) suffered a great deal of minor-to-major damage.

Housing in the rural area is predominantly of adobe and bajareque construction. Houses were destroyed or damaged in the rural sector up to approximately 30 km. away from the city of Popayán. It was estimated that 600 houses were destroyed or damaged.

COORDINATION WITH SENA

SENA was the primary recipient of the technical assistance provided by INTERTECT and funded by AID/OFDA. It should be noted that the SENA reconstruction program was well under way when the INTERTECT team arrived and as such the technical assistance provided served to complement and upgrade their program. The housing education program was developed specifically in support of SENA's "Self-Help Reconstruction Project" which organizes low-income earthquake victims into modules of 15 families and then trains them in self-help construction techniques with special emphasis on seismic resistant designs and technologies. This approach is low-cost, labor-intensive, uses locally-available materials, and generates local employment and business.

The short-term goal of SENA's program is to ensure that the communities are able to repair or reconstruct houses that will be safer (i.e., less vulnerable to future earthquakes) than the houses before the earthquake. The long-term goal is to promote cooperative

community action in achieving future economic and social development objectives. (For a more complete description of SENA's reconstruction program, see Appendix A.)

SPECIFIC INTERTECT ACCOMPLISHMENTS

Two courses in seismic resistant construction technology were given to the SENA instructors (a total of 40 instructors received training). Each course lasted approximately one week. An "Instructor's Manual" was developed and used as the basic text (see Appendix B). Furthermore, the instructors were trained to replicate this course at the field level for members of the community modules (approximately 1,500 families). It is expected that the instructors will also be giving the course (or parts of it) to other masons, carpenters and building craftsman, local government officials, school children, producers of materials, etc.

It should also be noted that 12 of SENA's construction instructors are on loan from regional SENA offices located in other parts of Colombia. It is expected that these instructors will return to their sites in early 1984 and give these courses in their own regions which are also prone to earthquakes.

Two similar courses in seismic resistant construction technology were given for persons in the construction industry (the Asociación de Maestros de Obra). Each course had 25 participants. Three trained SENA instructors helped teach the classes and will be continuing the week-long courses for at least 4 more weeks (again at 25 participants per course). Also attending these courses were the Municipal Building Inspectors and representatives of financial institutions.

Four "Model House Repairs" construction demonstrations were undertaken -- two for adobe houses and two for brick houses. The

four repaired houses were strategically selected in both urban and rural areas to have the largest possible demonstration value.

Simple and cost-effective methods for repair and strengthening of damaged buildings were introduced. Of particular interest was the introduction of chicken wire mesh to repair and strengthen adobe houses. The technique used is very simple and inexpensive, and it instilled much confidence in the homeowners regarding their "old adobe" homes (see Appendix B, "Como Reparar Una Casa de Adobe", for an illustrative description of the technology introduced).

Other techniques introduced during the hands-on training included:

--- rebuilding walls above horizontal and vertical cracks;
--- repairing areas around shear (diagonal) cracks;
--- reinforcing or rebuilding roof truss system;
--- anchoring roof trusses to ring beams;
--- replacing brick gable ends with lightweight construction;
--- replacing heavy clay tiles with lightweight roofing;
--- replacing bad wood members of roof system;
--- improving bracing and design of trusses;
--- lowering the total height of walls over 2.5 meters.

To help ensure the transfer of these technologies, three training aids were developed: "How to Repair Typical Damages", "How to Repair an Adobe House", and "How to Repair a Brick House" (see Appendix B).

A series of training aids was designed and produced that will facilitate the diffusion of information on seismic resistant construction techniques. The training aids were developed according to building types (i.e., brick and adobe) and designed for use by local carpenters, masons and self-help builders. The following aids were

developed and produced:

--- "How to Build a Safe Brick House" ("Como Construir una Casa Segura de Ladrillo") -- 500 copies printed;

--- "How to Build a Safe Adobe House" (to be printed by SENA in the future);

--- "How to Repair a Brick House" ("Como Reparar una Casa de Ladrillo") -- 500 copies printed;

--- "How to Repair an Adobe House" ("Como Reparar una Casa de Adobe") -- 500 copies printed;

--- "How to Repair Typical Damages" [for brick and adobe] ("Como Reparar Daños Típicos") -- 500 copies printed.

In addition, the following previously designed training aids were adapted for Popayán and produced:

--- "What Are Earthquakes" (" Que Son los Terremotos?");

--- "How Earthquakes Affect a House" ("Como Afecta el Terremoto a una Casa");

--- "Basic Principles of Seismic Resistant Construction" ("Principios Básicos de Construcción Sismo-resistente") -- 500 copies printed;

--- "Typical Damages" ("Daños Típicos);

--- "How to Inspect and Evaluate a House Damaged by an Earthquake" ("Como Inspeccionar y Evaluar una Casa Dañada por el Sismo");

--- "Damage Evaluation Form" ("Formulario para Evaluación de Daños").

Many of these training aids will be further reproduced in the local Popayán newspaper and other media avenues in order to reach a wider audience. In addition, a SENA artist was trained in the development of educational materials and is now available to SENA for the development of future training aids.

All of the training aids listed above (except for "How to Build a Safe Adobe House") were compiled and bound to make an "Instructor's Manual for Seismic Resistant Construction" (375 copies printed). The manual ("Construcciones Sismo-resistentes: Manual para Instructores") is attached as Appendix B to this report. Originals of all manuals were left with SENA/Popayán so that they will be available for future printings.

The INTERTECT team and SENA worked with the two key financial institutions -- the Banco Central Hipotecario (BCH) and the Instituto de Crédito Territorial (ICT) -- in developing minimum seismic resistant construction standards that were incorporated into the training aids. SENA, BCH and ICT are currently negotiating a formal agreement that would ensure the application of these minimum standards.

A meeting was held with the majority of the key institutions involved in the reconstruction of Popayán to outline the work in progress and the construction technologies employed. Steps were taken towards more involvement and better coordination of all institutions present which included:

--- professional architectural and engineering societies;
--- financial institutions;
--- local government technicians and officials;
--- regional planning authorities;
--- private construction industry;
--- Catholic Church.

Other activities included:

--- Provision of informal advice on management of the overall reconstruction program.

--- Provision of specific technical advice on an important new settlement for the poorest of the post-earthquake landless and homeless.

[Note: This new settlement (Barrio Colombia) is being financed through private donations of Colombian-Americans living in the U.S.A. and is of priority interest to Mrs. Belasario Betancur, wife of the Colombian president.]

--- Initial discussions with SENA and the Association of Colombian Earthquake Engineers on the need for a comprehensive Colombian hazard management program, a long-term housing vulnerability reduction program, and disaster mitigation and preparedness activities.

--- The Spanish version of the videotape, "Building for Safety in Hazardous Areas" (produced earlier by INTERTECT for AID/Office of Housing and AID/OFDA) was shown a number of times. SENA has made a copy to show throughout the country.

FINAL OBSERVATIONS AND RECOMMENDATIONS

To the degree that the technical assistance provided by INTERTECT and OFDA was useful, it would have been even more useful if provided earlier. The INTERTECT team arrived almost 5 months after the earthquake and many of the houses that could have been repaired were demolished; others were repaired incorrectly, and much new construction was already underway which was not earthquake resistant.

Information was very scarce; any kind of technical information on repair or reconstruction was highly sought-after by everyone in Popayán. Even the few training aids left by the first INTERTECT team in May had an impact in the area. AID/OFDA may want to consider putting together packets of post-disaster information that could be distributed along with initial emergency assistance. This information might include training aids from previous disasters in the same region of the world that have already been developed with OFDA funds, U.N. publications (e.g., UNDRO's Shelter After Disaster), and others. Translating these materials into Spanish, if needed, would be a major contribution.

The SENA reconstruction program could be an excellent model for other post-disaster programs by government agencies. OFDA may want to evaluate the program 6 months to one year from now and write up a case study in order to share the lessons with others.

SENA, along with the Colombian Association of Earthquake Engineers, is now thinking in terms of long-term earthquake mitigation and preparedness. AID/OFDA may want to support this effort in the future. Of immediate value would be the linking of these organizations with the network of people currently working in hazard management in the Dominican Republic, Jamaica, Venezuela, etc. AID/OFDA may also want to provide training opportunities (e.g., Ian Davis' Oxford Programme of Development Workshops) for key SENA people, especially the SENA/Popayán Director, Gustavo Wilches.

Finally, it should be noted that one of the INTERTECT team members, Daniel Torrealva, is a faculty member of the Pontificia Universidad Católica del Perú in Lima which hosted the Latin American Workshop on Seismic Resistant Earthen Construction. The Catholic University is also currently doing state-of-the-art AID-funded research on adobe technology. The team benefited greatly from the information and experience derived from the University's work.

It was felt by Ing. Torrealva that this field experience will be very helpful to the Catholic University during next year's phase of technology dissemination.

APPENDIX A

DESCRIPTION OF THE SENA RECONSTRUCTION PROGRAM

The Colombian institution with primary technical responsibility for repair and reconstruction efforts in Popayán is the "Servicio Nacional de Aprendizaje" (SENA). SENA has regional offices located throughout Colombia and has been providing a wide variety of vocational training since 1953. In the early 1970's SENA began offering courses in self-help construction. SENA's objectives have historically been to train people in the construction trades and to contribute toward the reduction of the housing deficit. SENA now has some 1,600 instructors in self-help construction and, during 1981, SENA gave technical assistance to the construction of some 2,000 housing units. SENA calculates that 10% of its trainees in self-help construction actually get jobs in the construction trades.

The SENA reconstruction program is made up of 4 major projects: Construction; Business Development and Job Creation; Vocational Training and Production; and Administration (see organizational chart on following page). All four of these projects were conceived and designed to be integrally related and focused on short-term reconstruction as well as long-term development of the affected communities. SENA's target population is the poorest of the earthquake victims.

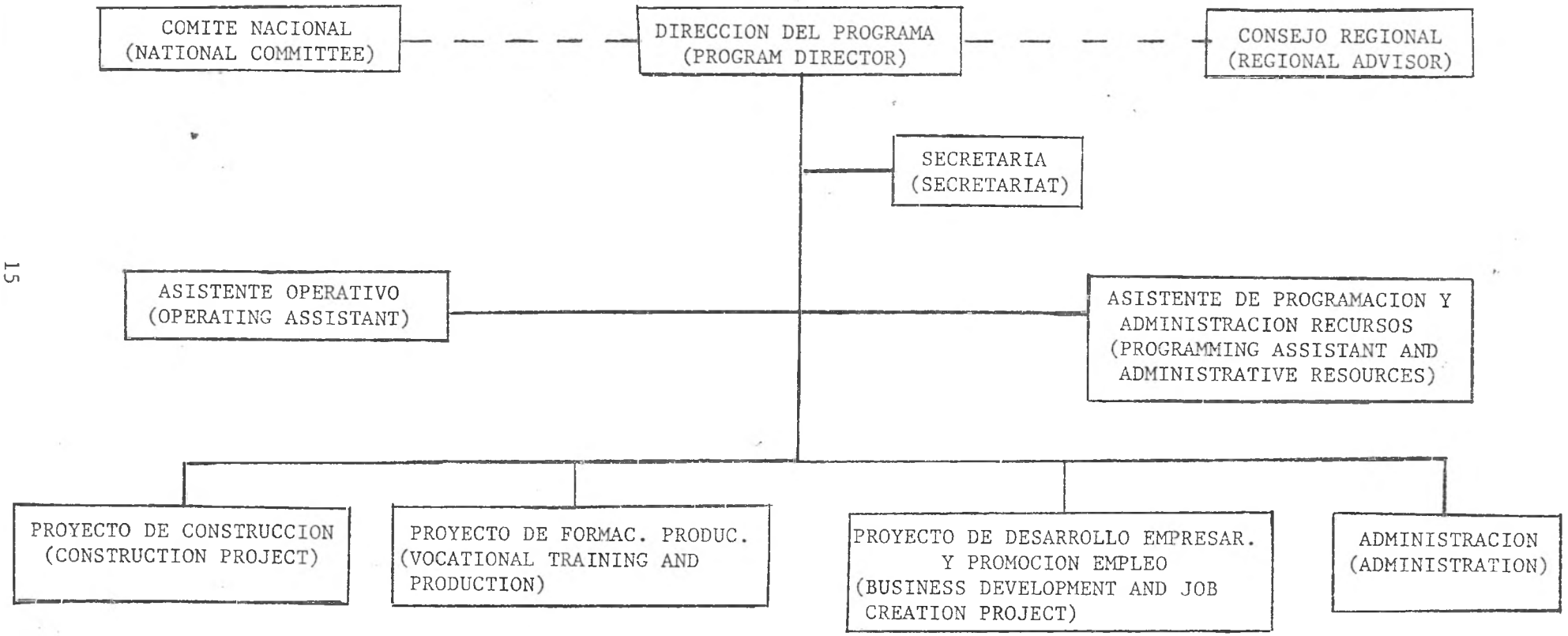
Construction Project:

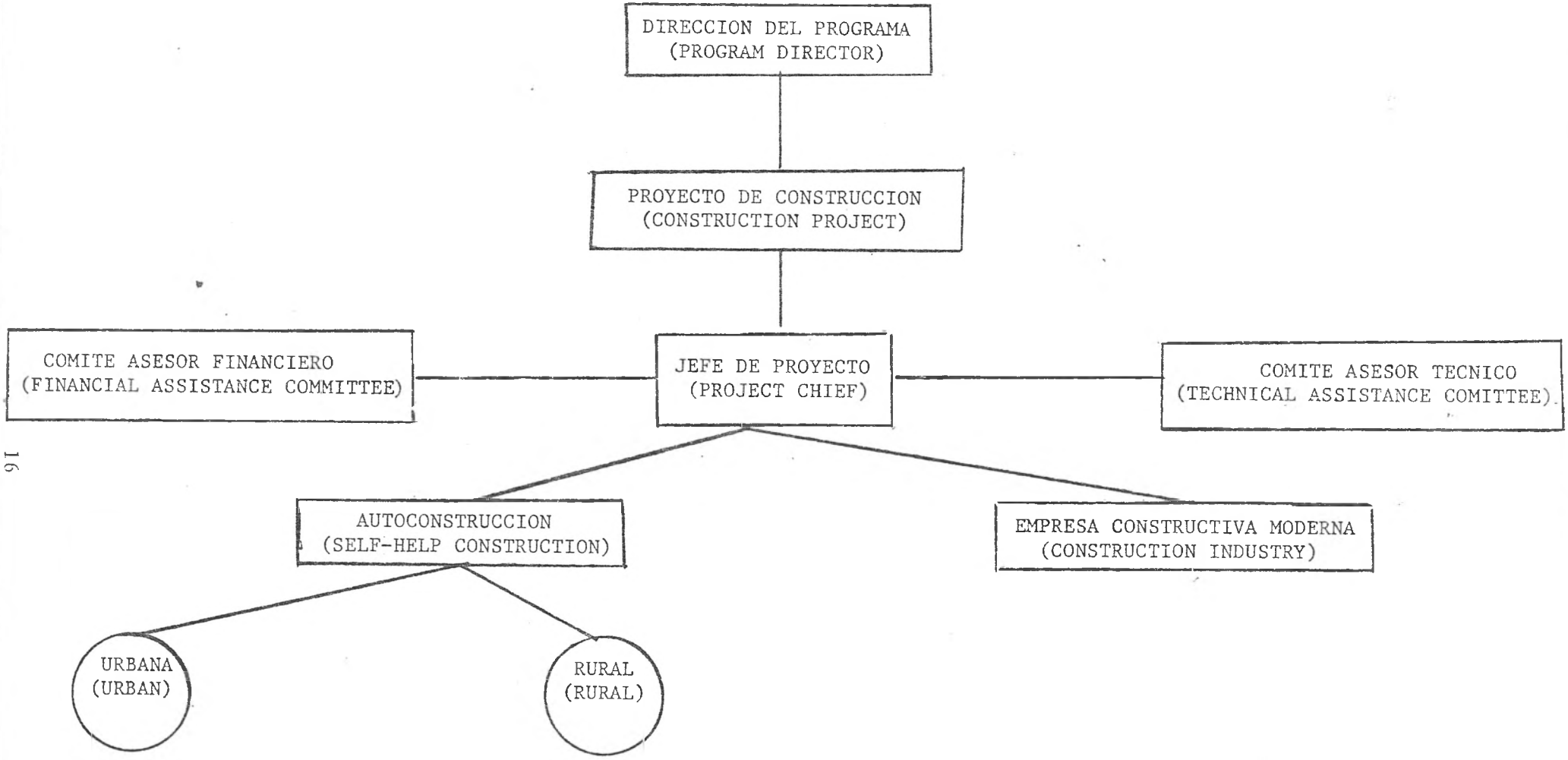
The Construction Project has two sub-projects: Self-Help Construction and Construction Industry (see chart, p. 16).

The Self-Help Reconstruction Sub-project is being carried out in 36 rural and urban communities (see maps on pages 2 and 3) and is adapted to the specific characteristics and circumstances of each urban "barrio" or rural "vereda".

S E N A

P R O G R A M A D E R E C O N S T R U C C I O N




DIRECCION DEL PROGRAMA
(PROGRAM DIRECTOR)
PROYECTO DE CONSTRUCCION
(CONSTRUCTION PROJECT)
COMITE ASESOR FINANCIERO
(FINANCIAL ASSISTANCE COMMITTEE)
JEFE DE PROYECTO
(PROJECT CHIEF)
COMITE ASESOR TECNICO
(TECHNICAL ASSISTANCE COMITTEE)
AUTOCONSTRUCCION
(SELF-HELP CONSTRUCTION)
EMPRESA CONSTRUCTIVA MODERNA
(CONSTRUCTION INDUSTRY)
URBANA
(URBAN)
RURAL
(RURAL)

The first objective that the self-help program seeks is to organize the community of victims with whom SENA will be working. The formally-organized entity then goes through a participatory developmental process through which it takes on the principal responsibility for the physical reconstruction process, as well as economic recovery and future development. In this manner, SENA seeks to support local coping mechanisms by acting as a catalyst for local initiatives, to promote cooperative community action, and to provide them with the group process skills to achieve their goals.

The second objective is the training of community members in self-help construction techniques, especially in seismic resistant designs and technologies. The ultimate goal is to enable the communities to repair or reconstruct houses that will be safer (i.e., less vulnerable to future earthquakes) than the houses before the earthquake.

The self-help construction approach is the most economically feasible reconstruction alternative for lower-income families because it is labor-intensive and uses locally-available materials. It also generates local employment and business. Most importantly, the self-help construction process is seen by SENA as an effective mechanism for members of the affected community to make decisions regarding their future homes.

The self-help construction program as designed by SENA results in the following:

--- A community organized around concrete and communal objectives and supplied with the associated mechanisms that will serve, after the reconstruction phase is completed, as a base for future developmental activities such as cooperative production and marketing efforts, construction of communal buildings and essential infrastructure, local disaster preparedness, etc.

--- Personnel that have been trained and organized to replicate the self-help construction process in other communities not directly participating in the SENA program.

--- A determinate number of permanently repaired and reconstructed houses that can later be expanded (as individual family resources allow) by family members who were trained in construction.

--- Trained individuals who will subsequently have opportunities to seek employment in the construction industry.

The type of housing to be constructed in each community is selected according to the socio-economic and cultural characteristics of each zone and agreed upon by the community. Thus, the houses may be constructed with adobe, CINVA-Ram blocks, bricks, "bajareque", etc., so long as they are built using basic seismic resistant construction principles.

For operational reasons, SENA has chosen to work with community modules of approximately 15 families as the basic unit. These community modules are organized around the basic goal of repairing or reconstructing homes through their collective efforts.

Each module is assigned a team comprised of a community development instructor and a construction instructor -- both of whom are SENA employees. Each family, in turn, provides two workers for a total of 30 construction workers. One of the two workers provided by the family is designated by SENA as a construction apprentice and is provided a small stipend to help make up for the loss to the family of his/her income during the reconstruction phase.

It is estimated that the average time for repairing a house is one month (depending, of course, on the amount of damage) and about 3 months for the construction of a new house.

SENA is also collaborating with certain international agencies (e.g., the World Food Program, UNICEF, etc.) and the local churches that are providing some food aid during the time that families are participating in the self-help reconstruction program.

The goals of the project (established in early April 1983) are to have completed by January 1, 1984:

--- one hundred community modules with an average of fifteen families, organized and trained in self-help construction techniques;

--- one thousand five hundred families reached in the rural and urban areas;

--- one thousand five hundred homes repaired or reconstructed;

--- one thousand five hundred apprentices trained in construction.

Aware that it could not be effective working in an isolated manner or unilaterally, SENA has collaborated and coordinated with a number of organizations including public, private, national and international agencies. In the urban areas, SENA has worked with the Banco Central Hipotecario (BCH) and the Instituto de Crédito Territorial (ICT), both of which provide financial credit. In the rural areas, SENA is collaborating with the Caja de Crédito Agrario (providing credit); the Programa de Desarrollo Rural Integrado (providing construction equipment); the Instituto Colombiano de la Reforma Agraria (providing equipment and construction materials); the Dirección de Integración y Desarrollo de la Communidad (providing credit). SENA has also collaborated with UNICEF, the U.N. Development Programme, the International Labor Organization, and the Catholic Church.

Among all of the above institutions, SENA is seen as the main provider of technical assistance.

Anticipating a large demand for qualified construction workers in the private construction sector, SENA also developed a Construction Industry Sub-project to train people more formally in plumbing, masonry, framework, bricklaying, reinforced concrete work and others. In addition, special "continuing education"-type courses are given to members of the professional and construction community in seismic resistant construction.

Briefly, the two other projects under the overall SENA reconstruction program are:

Vocational Training and Production Project:

The "Centro Múltiple" was SENA/Popayán's complex for vocational and artesan training prior to the earthquake. It has now been redesigned as a training/industrial center that produces construction materials which will be used to support the self-help construction program. Materials produced include doors, windows, metal trusses, etc. In addition to producing needed construction materials, this program provides vocational training in electrical installation, welding, metalworking, carpentry, etc.

Business Development and Job Creation Project:

Perhaps even more important than the reconstruction of houses is the reconstruction of the economy of the region which suffered the loss of small, medium and large manufacturers and businesses. This project seeks to reactivate business at all levels, but especially the small and micro-enterprises that were most affected by the earthquake.

APPENDIX B

CONSTRUCCIONES SISMO-RESISTENTES: MANUAL PARA INSTRUCTORES